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Straub

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[54] **FLUIDIC ANTISKID CIRCUIT**

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[52] **U.S. Cl.** ..... **303/21 CG;** 137/805; 188/181 A; 244/111

[51] **Int. Cl.²** **B60T 8/04**

[58] **Field of Search** ..... 137/804, 805; 188/181 C, 181 A; 235/200 PF, 201 PF; 244/111; 303/20, 21

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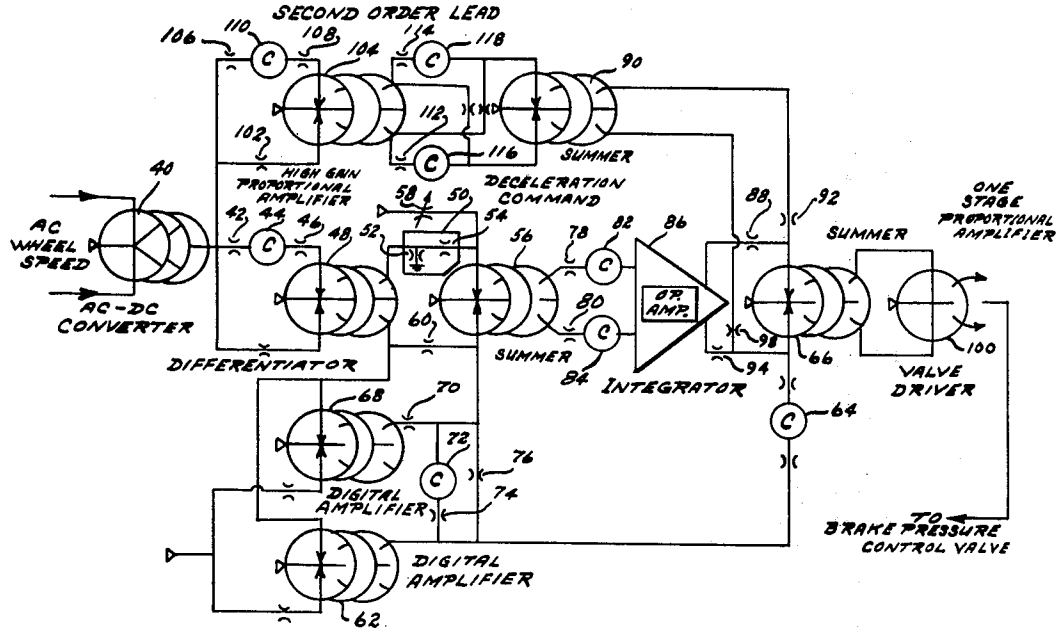
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[57] **ABSTRACT**

A pneumatic wheel speed sensor provides pulse frequency signal proportional to wheel speed, the signal is converted to DC signal and differentiated and compared to commanded deceleration, error which causes modulation of brake pressure. Excessive deceleration causes a digital amplifier to switch into the system an integrator resulting in rapid brake pressure signal decrease. A second order lead protects against undesirable landing gear oscillation in aircraft applications.

1 Claim, 2 Drawing Figures



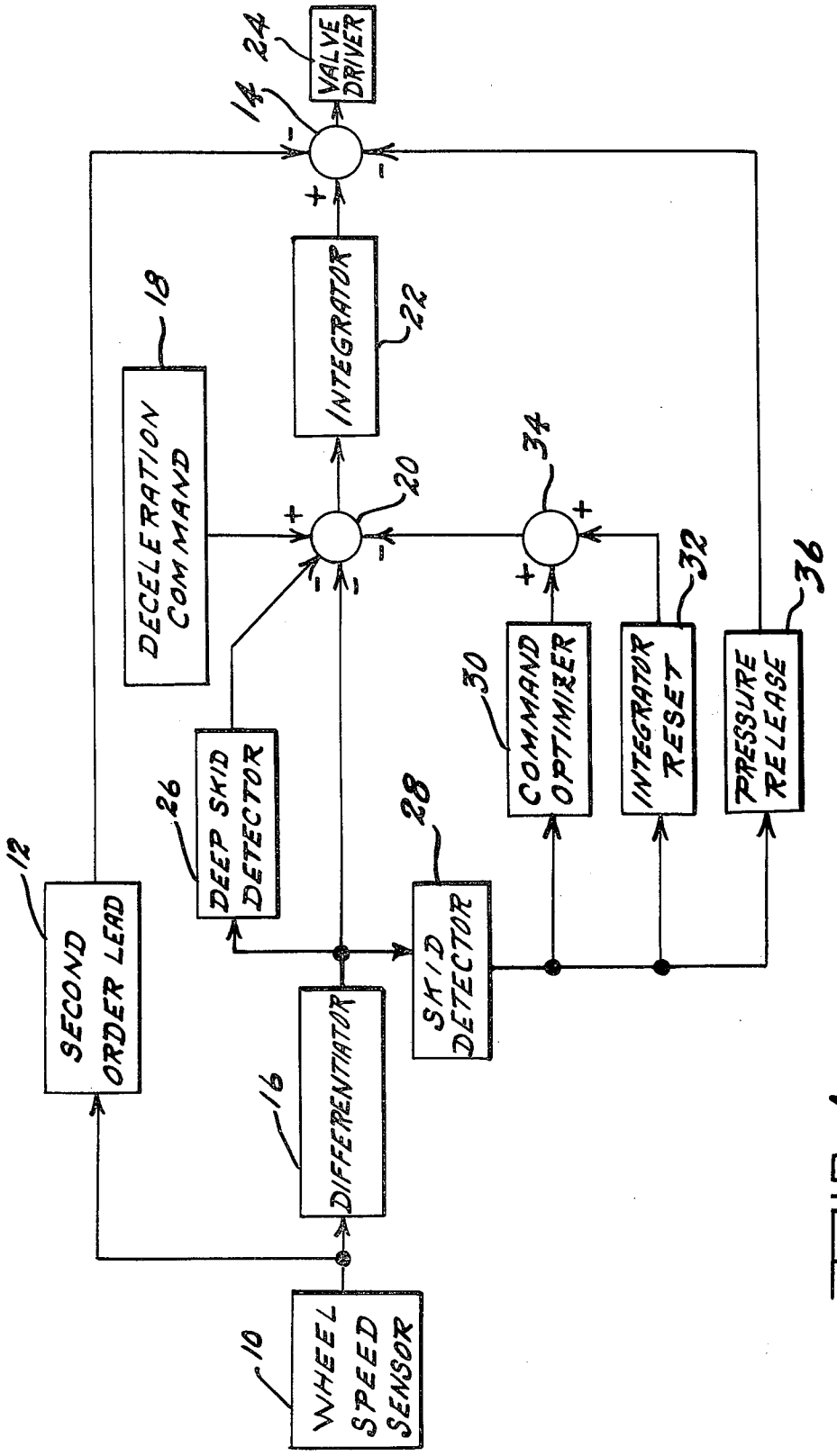

WHEEL SPEED SENSOR
10
SECOND ORDER LEAD
12
DIFFERENTIATOR
16
DECELERATION COMMAND
18
INTEGRATOR
22
VALVE DRIVER
24
DEEP SKID DETECTOR
26
SKID DETECTOR
28
COMMAND OPTIMIZER
30
INTEGRATOR RESET
32
PRESSURE RELEASE
36
14
20
34
+
-

FIG. 1

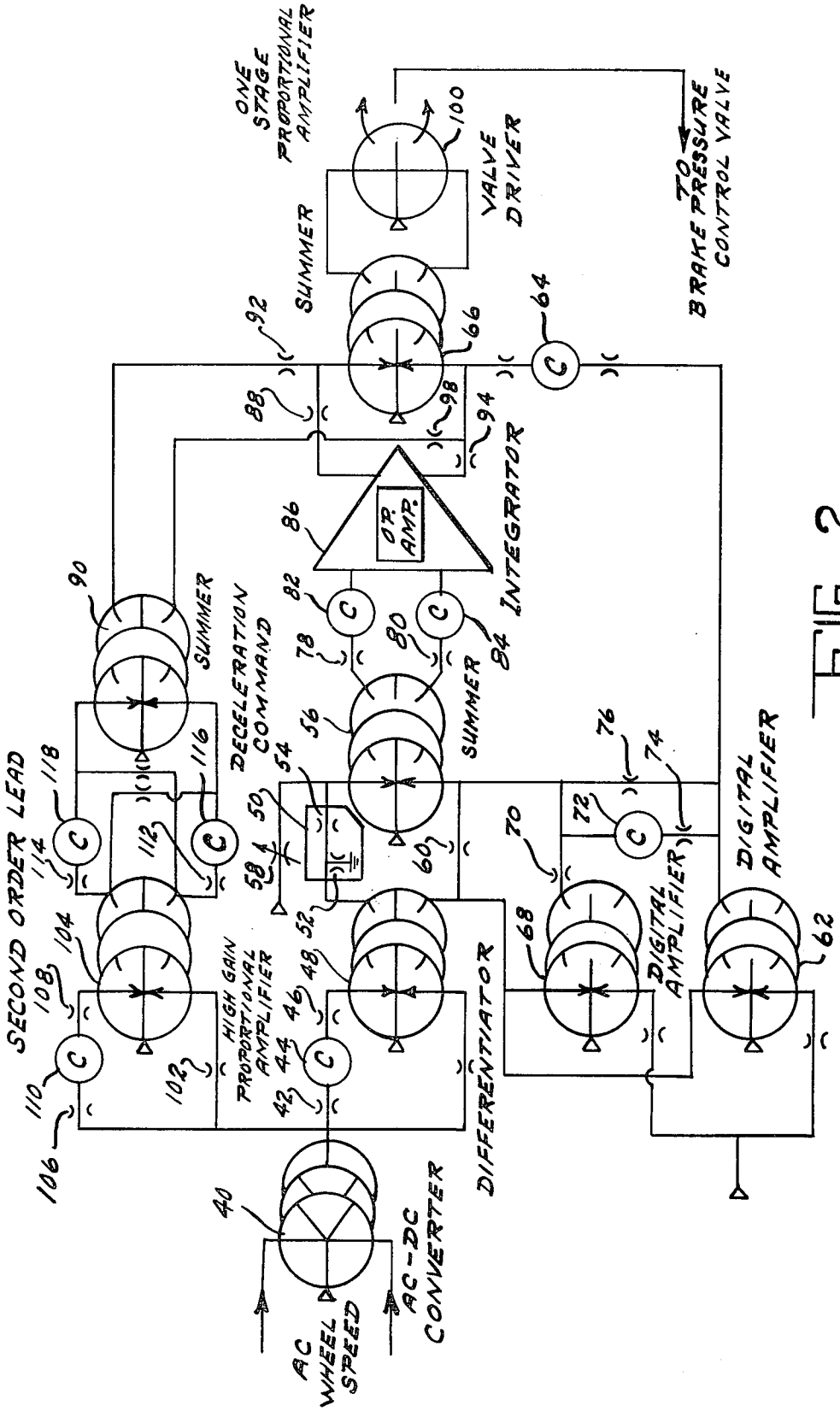

ONE STAGE PROPORTIONAL AMPLIFIER
SUMMER
VALVE DRIVER
TO BRAKE PRESSURE CONTROL VALVE
INTEGRATOR
OP AMP
DECELERATION COMMAND
SECOND ORDER LEAD
HIGH GAIN PROPORTIONAL AMPLIFIER
DIFFERENTIATOR
DIGITAL AMPLIFIER
AC WHEEL SPEED
AC-DC CONVERTER

FIG. 2

FLUIDIC ANTISKID CIRCUIT

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

BACKGROUND OF THE INVENTION

This invention relates generally to systems for the prevention of vehicular skidding and more particularly to a fluidic antiskid system that will function under adverse conditions.

Due to the increase in technology in the field of all weather landing systems, it is now possible for aircraft to land under conditions hitherto not possible. However, when the aircraft has reached the runway, another hazard presents itself in the form of skidding because of wet, snow or ice covered surfaces. As aircraft grow larger, landing speeds increase and the need for a suitable antiskid system increases.

Ali vehicular antiskid systems must, in one manner or another come in direct contact with the braking system of each wheel of the vehicle. Because of the high energy disipation involved in braking systems, the wheel units constitute a hostile environment for most electrical components. The heavier the vehicle the more severe the temperature ranges in the braking system. For example, a small automobile would necessarily produce less heat than a large aircraft, all other factors being equal. Coincident with the effects of heat are the deleterious effects of vibration on any wheel mounted equipment. The vehicle whether large or small will be subject to substantial shocks and pounding from both constant highway travel and runway landings.

In addition to the problem of suitable construction materials, antiskid systems utilized in aircraft must compensate for the destructive effects of "gear walk". All antiskid systems involve some type of speed sensing, and the ultimate controlled application and release of appropriate braking systems. Since this is a rapid function frequently a harmonic frequency is created between the braking system and the natural flexing of the landing gear called "gearwalk". Unless controlled, this harmonic could damage the landing carriage and cause loss of effective ground control during stopping.

SUMMARY OF THE INVENTION

The invention utilizes a new and improved combination of fluidic components to achieve antiskid effects in vehicles. Fluidic components operate under the adverse effects of temperature and vibration that tend to shorten the life of prior art systems. These components facilitate the construction of an integrated antiskid system by placing the brake control system in very close proximity with the brake.

In general, a wheel speed signal enters the circuit and is differentiated to result in a wheel deceleration factor. A command rate of deceleration is sent to the system and the difference between the actual deceleration factor and the command rate level of deceleration is fed into an integrator which then modulates the pressure sent to the braking system for that wheel.

In operation, if actual wheel deceleration exceeds certain set values, skid detectors sense the tendency for the wheel to lock up. When incipient skid is sensed, the detectors act to release pressure on the appropriate brakes and reset the integrator to a lower value.

When the system is utilized with aircraft, the additional factor of "gear walk" must be taken into account. In order to compensate for harmonics generated between the vibrations of the landing gear and the pulsing action of the antiskid system, a second order circuit is provided which is tuned to each particular aircraft's landing gear. The second order circuit anticipates the deceleration rate and avoids the buildup of destructive harmonics.

It is therefore an object of the invention to provide a new and improved fluidic antiskid circuit.

It is another object of the invention to provide a new and improved antiskid circuit that functions in the hostile environment of heat and vibration.

It is a further object of the invention to provide a new and improved antiskid circuit that obtains maximum traction at the surface-tire interface.

It is still another object of the invention to provide a new and improved antiskid circuit that provides for damping to protect against undesirable gear oscillations.

It is still a further object of the invention to provide a new and improved antiskid circuit that will provide an increased lifetime over those known in the art.

It is another object of the invention to provide a new and improved fluidic antiskid circuit having improved performance characteristics over known similar circuits.

It is another object of the invention to provide a fluidic antiskid circuit which is economical to produce and utilizes conventional currently available components that lend themselves to standard mass production manufacturing techniques.

These and other advantages, features and objects of the invention will become more apparent from the following description in connection with the illustrative embodiment in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the invention.

FIG. 2 is a flow diagram of the invented circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a pneumatic wheel speed sensor **10** provides a pulse frequency which is directly proportional to wheel speed. The pulse frequency is converted to a DC signal in the circuit. The signal is differentiated at **16** and provides a wheel deceleration signal for computation purposes. The actual deceleration is compared to a command deceleration **18** in the summer **20** and the resulting error drives the integrator **22,** summer **14** and valve driver **24** to modulate the brake pressure.

In the event that wheel deceleration becomes excessive, it is sensed at the skid detector **26,** a digital amplifier **28** is switched into the integrator, resulting in a rapid decrease in brake pressure signal thereby keeping a skid at a minimum level, two such digital amplifiers are provided to switch at a different wheel deceleration. The second digital amplifier includes skid detector **28** which functions in cooperation with the command optimizer **30** and integrator reset **32** whose outputs are summed at **34** and sent to the summer **20.** The pressure release subsystem is connected directly to the summer **14** bypassing the integrator **22.**

A circuit providing the derivative of deceleration is shown as the second order lead **12** this provides damping to protect against undesirable landing gear oscillations. The valve driver **24** delivers a signal to an interface valve which converts anti skid signals to corresponding brake pressures.

Concerning FIG. **2**, the AC wheel speed signal is fed to the AC-DC converter **40**, thence through the orifices **42, 46** and the air volume capacitor **44** and on into the differentiator **48.** The output of the differentiator is fed through the deep skid detector, consisting of orifices **52** and **54** to the summer **56.** Also fed to the summer through the variable orifice **58** is the deceleration command. The output from the differentiator is also fed through the orifice **60** directly to the summer **56.** The output then continues as input to the digital amplifier **62** which is effectively a bi-stable amplifier. The output of the amplifier **62** is sent through the capacitor **64** to the summer **66.** The digital amplifier **68** receives input from the differentiator **48** and provides an output which, after passing through the orifice **70** combines with the output from the amplifier **62** as modified by the capacitor **72,** and orifices **74, 76** to provide additional input to the summer **56.** Output from the summer **56** is fed through orifices **78** and **80** and volume capacitors **82** and **84** in separate channels to the operational amplifier-integrator **86.**

Output from the integrator is fed through orifice **88** where the signal is combined with the signal from the second order lead, summer **90** after passing through orifice **92** and thence to the summer **66.** The second output of the integrator passes through the orifice **94,** is combined with the second output from the summer **90**

after passing through the orifice **98.** The combined signal is then joined with the signal from the digital amplifier **62** and sent to the summer **66.** The output of the summer **66** is then fed via two channels to the valve driver **100** which is in practice a one stage proportional amplifier. The output of the valve driver is then fed to the appropriate brake pressure control valve.

The second order lead receives a signal from the AC-DC converter **40** where the signal is split taking one leg of the circuit passing it through orifice **102** to the high-gain proportional amplifier **104.** The second leg of the circuit passes through orifices **106, 108** and air volume capacitor **110** into the amplifier **104.** The amplifier output is modified by the restrictive orifices **112, 114** and capacitors **116, 118,** and sent to the summer is combined with output from the integrator **86** as explained hereinbefore.

Having thus described my fluidic antiskid circuit, I make the following claims of the invention:

1. A fluidic antiskid circuit comprising: a pneumatic wheel speed sensor connected to a wheel; means for determining the rate of deceleration of the wheel; means for comparing the rate of deceleration with a preselected rate of deceleration, and producing an output signal; valve means connected to a wheel braking system and adapted to receive said output signal whereby braking pressure is varied according to the deceleration rate, and means for detecting and compensating for excessive wheel deceleration, including a fluidic digital amplifier connected to said means for comparing deceleration rates.

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